Temporary night penning as effective tool to improve plant diversity in nutrient-poor dry grasslands

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Abstract

Socio-economic transformations occurred in Europe over the last decades have led to a change in land use intensity with a broad abandonment of mountain areas. Especially in semi-natural grasslands, the decline in workforce and in the number of stocked animals has resulted on the long term in a loss in plant diversity, often depending on standing-dead litter accumulation, which is known to change competitive relations among plant species. To restore plant diversity and vegetation structure by reducing standing-dead litter, we arranged five temporary night pens (TNP) over nutrient-poor dry grasslands of the Natura 2000 site IT1110030 (Western Italian Alps). Within each TNP, we fenced 250 sheep for 2-3 nights and we surveyed vegetation along permanent transects before the arrangement of TNP (2015) and one year after treatment. We evaluated the effects on herbaceous, rock and bare ground cover, and we computed biodiversity indices (species richness and Shannon diversity index (H')). Temporary night penning reduced the abundance of standing-dead litter and herbaceous cover ($P < 0.01$), and increased bare ground ($P = 0.004$). Furthermore, the number of plant species increased ($P < 0.001$), whereas H' did not change significantly. These short-term findings highlight that plant-diversity restoration in abandoned dry grasslands may benefit from temporary night penning practice.

Keywords: Abandoned grasslands, Sheep, Species richness, Standing-dead litter, Vegetation structure

Introduction

The reduction of agro-pastoral practices in the European mountains in the last decades has affected the ecosystem services provided by semi-natural grasslands. In particular, the accumulation of standing-dead litter, which changes competitive relations among plant species, may result in a progressive loss in biodiversity. Temporary night camp areas for cattle are known to enhance vegetation structure and increase biodiversity in sub-alpine grasslands (Tocco *et al.*, 2013, Pittarello *et al.*, 2016), but any information is available in literature about the implementation of Temporary Night Penning (TNP) for sheep. Sheep, are often better suited for grazing on steep slopes and rugged areas than cattle, as they are lighter and more agile (Crofts and Jefferson, 1999). The objective of this research was to assess the effects produced

by TNP on vegetation structure and botanical composition on the short-term period in abandoned dry grasslands (*Festuco – Brometea* class), which represent one of the most threatened habitats in Europe.

Materials and methods

The research was conducted within the Natura 2000 site IT1110030 (Western Italian Alps - 45°08' N, 7°06' E). The study area was a pasture of 120 ha ranging between 510 and 1260 m a.s.l. and abandoned since the '50. Dry grasslands were mainly dominated by *Stipa pennata* L., *Bromus erectus* Hudson, and *Festuca ovina* s.l. (habitats 6210* and 6240*, Annex 1 of Directive 92/43/CEE). Within the pasture, which was grazed for the first time by a flock of 250 'Bergamasca' sheep for 32 days (April 15th to May 16th 2015), five temporary night pens (TNP) were arranged over nutrient-poor herbaceous areas. The flock was confined for 2-3 consecutive nights within each area (820 m^2, on average) delimited with electric fences. Within each TNP, botanical composition was determined using the vertical point-quadrat method along five to six permanent linear transects (Pittarello *et al.*, 2016). Each transect was 12.5-m long and at every 25-cm interval plant species touching a steel needle were identified and recorded. For each plant species recorded in each transect, the frequency of occurrence (f_i= number of occurrences/50 points of vegetation measurement) was calculated. Within 1-m buffer around the linear transect (vegetation plot), the percentage of herbaceous, rock, and bare ground cover was visually assessed to give an estimate of the basal cover. Moreover, all other plant species not recorded along the transect were listed. The abundance of standing-dead litter and live biomass were estimated using four abundance categories: 1= Null, 2= Scarce, 3= Medium, and 4= Abundant. Surveys were carried out during spring 2015, before fencing the flock into night pens (pre-treatment), and in spring 2016, one year after treatment. Biodiversity was expressed as species richness (number of plant species within each vegetation plot) and by Shannon diversity index (H') (computed for each vegetation transect as described by Pittarello *et al.*, 2016). Paired-samples *t*-tests were used to evaluate the differences between year 2015 and 2016 for vegetation structure variables (percentage of herbaceous, rock, and bare ground cover) and biodiversity indexes. Shapiro-Wilk test for normality and Levene test for homogeneity of variance were used to evaluate the variable distribution. The sequence of transition of standing-dead litter and live biomass abundance categories from 2015 to 2016 was calculated for each vegetation plot and the dyads of the preceding and following scales were evaluated with a transition matrix. The transition matrix was compared to a random model using Chi-square analyses to assess changes in standing-dead litter and live biomass one year after treatment.

Results and discussion

One year after the implementation of TNP vegetation structure changed and species richness increased. Trampling by sheep caused a moderate reduction of herbaceous cover (about -6%) and an increase of bare ground (+6.4%), without compromising the sward excessively or inducing soil erosion (Table 1). As expected, rock cover did not change after treatment. The standing-dead litter reduced in abundance in 20 vegetation plots out of 27 (Table 2): in ten vegetation plots it shifted from medium to scarce, in three from abundant to medium, and in two from abundant to scarce. Only within one vegetation plot an increase was observed (from scarce to medium), whereas in the remaining six ones abundance did not change. Conversely, one year after treatment, the live biomass did not show variation in most of the vegetation plots (15) (Table 2). The general enhancement of vegetation structure had positive effects also on the species richness, which increased of about seven plant species in each vegetation plot, on average (Table 1). It is worth mentioning that many of these species were annual plants, which probably took advantage of the gaps created by sheep trampling. Such gaps favoured also some perennial plant species (e.g. *Briza media* L., *Trifolium montanum* L. and *Brachypodium*

sylvaticum Hudson Beauv.) which probably germinated by transient seeds in the soil. Moreover, sheep may have acted as vectors for herbaceous seeds from adjacent grazed pastures, fostering the recolonization process of bare ground gaps. Instead, H' did not change significantly, as the abundance of plant species in 2015 and 2016 had similar distribution.

Conclusion

The implementation of TNP was an effective tool to enhance vegetation structure and to increase species richness in semi-natural dry grasslands even on the short-term period. However, these results represent a starting point for a longer monitoring-period, necessary to better evaluate the effectiveness of TNP.

Table 1. Effects produced by the arrangement of five Temporary Night Pennings (TNP) on vegetation structure and biodiversity indexes. Values are means and mean standard errors (S.E.).

	2015	2016			
Vegetation structure	mean ± S.E.	mean ± S.E.	t	d.f.	*P*-value
Herbaceous cover (%)	81.8 ± 2.17	75.8 ± 1.82	2.94	26	**
Bare ground cover (%)	16.0 ± 1.94	22.4 ± 1.6	-3.17	26	**
Rock cover (%)	2.2 ± 0.57	1.8 ± 0.29	1.05	26	ns
Biodiversity indexes					
Number of species	37.9 ± 1.11	44.8 ± 1.15	-6.10	26	***
Shannon diversity index (H')	3.0 ± 0.05	3.1 ± 0.05	-0.84	26	ns

*** = $P < 0.001$; ** = $P < 0.01$; * = $P < 0.05$; n.s. = not significant ($P > 0.05$)

Table 2. Transition matrix and Chi-square analyses for the period 2015-2016 of the abundance categories for standing-dead litter and live biomass.

		Standing-dead litter 2016				Live biomass 2016			
2015		1	2	3	4	1	2	3	4
1 – Null	Observed	0	0	0	0	0	0	0	0
	Expected	0	0	0	0	0	0	0	0
	Chi-square	-	-	-	-	-	-	-	-
2 – Scarce	Observed	3	1	1	0	0	0	1	0
	Expected	0.9	2.4	1.7	0	0.0	0.0	0.9	0
	Chi-square	4.6	0.8	0.3	-	-	0.0	0.0	0.1
3 – Medium	Observed	1	10	5	0	0	1	15	2
	Expected	3.0	7.7	5.3	0	0.0	0.7	16.0	1
	Chi-square	1.3	0.7	0	-	-	0.2	0	0.3
4 – Abundant	Observed	1	2	3	0	0	0	8	0
	Expected	1.1	2.9	2	0	0.0	0.3	7	1
	Chi-square	0	0.3	0.5	-	-	0.3	0.1	0.6
		Overall Chi-square= 8.53				Overall Chi-square= 1.69			
		df= 9				df= 9			
		P= 0.074				*P= 0.793*			

References

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